Mrs. Wallace; a Lion (*Felis leo*, ♂) from North Africa, presented by Mr. P. B. Vanden Byle; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Mr. Palmer; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. Chambers; two Shags (*Phalacrocorax graculus*) from Scotland, presented by The Maclaine of Lochbuie; three European Pond Tortoises (*Emys orbicularis*) from Italy, presented by Miss E. Endicott; two Axolotls (*Amblystoma tigrinum*) from Central America, presented by Mr. W. R. Temple; a Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Clyde Hinshelwood; two Common Snakes (*Tropidonotus natrix*) from Germany, presented by Mr. A. Waley; two Orang-outangs (*Simia satyrus*, ♂ ♀) from Borneo, a Squirrel Monkey (*Chrysothrix sciurea*) from Brazil, a Gentoo Penguin (*Pygosceles tæniatus*) from the Falkland Islands, a Maguari Stork (*Dissura maguari*) from South America, two Thick-billed Penguins (*Eudyptes pachyrhynchus*) from New Zealand, a Jardine's Parrot (*Pæocephalus gulielmi*) from West Africa, two —— Honey-eaters (*Ptilotis*, sp. inc.) from Australia, two Elephantine Tortoises (*Testudo elephantina*), a —— Tortoise (*Testudo*, sp. inc.) from the Aldabra Islands, deposited; five Bridled Wallabies (2 ♂, 3 ♀) from Australia, five Ruffs (*Machates pugnax*), two Redshanks (*Totanus calidris*), two Spoonbills (*Platalea leucorodia*), European, ten Common Chameleons (*Chamæleon vulgaris*) from North Africa, purchased; a Macaque Monkey (*Macacus cynomolgus*), two Japanese Deer (*Cervus sika*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE (JUNE 14).—The following is the ephemeris for comet Perrine for the ensuing week:—

1898.	R.A. h. m. s.	Decl. ° ′	Br.
July 21	6 38 7	+38 52·3	3·96
22	42 6	37 58·0	
23	46 4	37 2·6	
24	49 59	36 5·9	
25	53 51	35 8·1	4·67
26	57 41	34 9·1	
27	7 1 29	33 8·9	
28	7 5 16	32 7·5	

A NEW FORM OF GRATING SPECTROSCOPE.—Prof. Michelson describes, in the *Astrophysical Journal* for June, a spectroscope which seems specially adapted for examining any particular line in a spectrum. The idea is that in a grating it is desirable sometimes to be able to throw a large proportion of light into very high orders of spectra—the hundredth, for example—and according to the arrangement here adopted the method seems quite simple. The problem becomes still more simple if the grating be arranged for transmission, as the grating can then be efficiently constructed if one can make a considerable number of plane-parallel plates of glass of the same thickness. Using only seven elements—that is, seven of these plates of glass arranged in step fashion—and placing them between a collimator and an observing telescope, and the collimator slit illuminated by a sodium flame, the broadening of the lines could be easily detected, and the Zeeman effect readily observed when the sodium flame was placed in a magnetic field. The resolving power of this instrument being independent of the number of glass plates, but depending only on the total thickness, the only advantage gained in using a large number of elements is that the spectra are more separated. With a few elements the spectra overlap; but this, as is pointed out, does not make much difference if effects of broadening, shifting or doubling of single lines be alone attempted. A spectroscope with twenty elements has already been in use in the Ryerson Physical Laboratory, and Prof. Michelson is now having another constructed giving greater resolving power, and sufficient for the analysis of close groups of lines.

STRUCTURE OF THE H AND K LINES.—Mr. Jewell tells us (*Johns Hopkins University Circular* for June) that while examining a series of photographs of the solar spectrum made by Prof. Rowland in 1888 and 1889, he discovered one plate on which the shading of the H and K lines of calcium was broken up into bands or series. These bands were noticed to begin at the centre of the shaded lines and extend outward, the distance between the component lines of the series increasing as the distance from the centre increased. Further, the series were perfectly symmetrical about the centres about H and K, and the individual lines or components somewhat nebulous, while nearly all the other lines in the same region were sharp and clear. Since that date Mr. Jewell has not been able, except quite recently, to detect this peculiarity in the photographs taken by himself; but, on March 11 last, a plate was exposed to the arc spectrum of calcium (λ 4000) under somewhat special conditions, and this showed the shading broken up into series. The shading on the red side of H was quite distinctly broken up into series similar to those of the solar spectrum mentioned above. The series on the violet side was not so distinct; while the shading is better on the violet side of K than on the red side. Mr. Jewell further says that the resolution into lines is hardly perceptible close to the principal line, but is fairly distinct about three Ångström units from H. Curiously enough, the lines of the series in the arc spectrum plate are reversed; but some distance away from the central lines it is probable that they are continued as emission lines.

To obtain this negative an extremely powerful direct electric current was used, being allowed to act for a short time before the image of the poles was thrown on the slit of the spectroscope, the length of exposure being three to four seconds. In this way the calcium was highly volatilised, and the "highly heated vapour formed a much more extended atmosphere around the poles than with a weaker current; and it is also possible that the conditions throughout the larger part of the arc were more uniform than under ordinary circumstances." Mr. Jewell thinks that, in the case of the solar spectrum referred to, the slit of the spectroscope probably covered a region of the sun's atmosphere where the principal layer of the calcium was of a particular density, and being thus to a degree isolated was able to produce its characteristic series. This, he says, is somewhat confirmed in that the general shading of H and K on the plate is unusually weak.

BLURRING ABERRATION IN THE TELESCOPE.—In the note which previously appeared in this column (May 26, p. 88), we referred to Mr. Collins' paper on this subject, and remarked that the tilting of the image not only occurs in the case of the reflector, but in that of the refractor also; the effect in the latter case being twice as great as that in the former. We should, however, have made it clearer if we had stated that the tilt is really the same in both instruments of like angular aperture, but the difference in the inequality of size of the images formed from the "marginal" and "central" portions of aperture focussed on a single focal plane is twice as great in the ordinary refractor as with the reflector. The images formed from the central portion of the reflector are smaller than those formed by the marginal rays, while with the refractor the marginal rays produce smaller images than the central rays passing through the lens.

THE LIFE-HISTORY OF THE SALMON.[1]

THE investigations recorded at length in this Report are partly of biological, partly of more purely physiological interest. They were undertaken with the following objects:—

(1) To elucidate some of the factors governing the migration of the salmon, and to study the course of these migrations.

(2) To determine whether or not Miescher is right in his contention that salmon do not feed during their sojourn in fresh water.

(3) If salmon while in the river do not procure an abundance of food, to investigate from what source they obtain the energy for the large amount of muscular work they perform, and whence comes the material to build up the enormous genitalia which are developed before spawning. Such an investigation must necessarily yield information of interest as to the chemical changes of various substances in the animal body.

---

[1] "Report of Investigations on the Life-History of the Salmon in Fresh Water." From the Research Laboratory of the Royal College of Physicians of Edinburgh. Edited by D. Noël Paton, M.D., Superintendent of the Laboratory. A Report to the Scottish Fishery Board presented to Parliament by command of Her Majesty. (John Menzies and Co., Edinburgh.)

The method employed was as follows. From the constant stream of salmon setting from sea to river specimen fish were taken (1) from the estuaries just as the fish were leaving the sea, and (2) from the upper reaches of the river. The rivers selected were the Spey, Dee and Helmsdale. Fish were taken from these stations at three periods: (1) in May and June; (2) in July and August; (3) in October and November.

By comparison of the fish from the upper waters with those just leaving the sea the nature and extent of the changes during the passage of the fish up the rivers were determined. The method may be compared to that of taking samples of the water of a river from two points in order to determine the changes between these points.

In the course of these investigations results obtained from salmon of very different sizes had to be compared, and therefore all weighings, &c., were expressed in terms of a fish of uniform length—the standard fish. The length selected was 100 cm.

The number of fish examined was 104, a number small as compared with the myriads of fish which ascend the rivers. It was considered necessary to investigate how far these fish were fair average specimens of their classes. Mr. Archer's extensive series of measurements and weighings of salmon from various stations enabled him to ascertain that the female fish examined by us were really average specimens, but that the small number of male fish with which we had to deal were not so typical. It is from observations on female fish that our conclusions are drawn.

The first question dealt with was the evidence as to whether salmon feed in fresh water. Dr. Gulland shows that the salmon coming from the sea early in the summer has the stomach lined with a perfectly developed mucous membrane, while in the intestine the mucous membrane is somewhat degenerated. In fish taken from the upper waters the mucous membrane of stomach and intestine are intensely degenerated. In kelts—spawned fish passing back to the sea—there is a regeneration of the mucous membrane.

Dr. Gillespie has investigated the activity of the digestive secretions by preparing in the usual manner glycerin extracts of the mucous membrane of the stomach and intestine. He finds in every case a very low digestive power. From this he concludes that the fish even when approaching to the river mouth have practically ceased to feed.

His further studies of the bacteriology of the alimentary canal show that, while in all situations, as might have been expected, the number of bacteria varies directly with the temperature of the water, in fish from the upper water there is usually a larger number of bacteria, and more especially a larger number of putrefactive bacteria than in fish from the estuaries. From this he concludes that the secretion of acid must be in abeyance in the former.

These investigations, taken with the evidence adduced by Miescher, seem to leave no doubt that the salmon does not *digest* and *use* food during its sojourn in fresh water.

It is because of this prolonged fast, and because of the important changes going on in the fish during the fast, that so interesting a physiological study in metabolism is afforded. An opportunity is offered of investigating the manner in which materials are stored in the animal body, the extent to which they may be transferred from one organ to another, the nature of some of the chemical changes they undergo, and the extent to which the various stored materials are utilised as a source of energy.

Evidence is adduced to show that the fish taken in the upper waters in May and June may have entered the river earlier in the year, and it is therefore not considered fair to compare them with the estuary fish of that period. On the other hand, there is evidence that the fish leaving the sea from May to August go to the upper waters, and hence the upper water fish of July and August are compared with the estuary fish of May to August. Evidence is also presented to show that the fish leaving the sea in October and November do not pass to the upper reaches during these months. Hence the upper water fish of October and November are to be compared with the estuary fish of May to August.

Adopting this method of comparison, the following results have been obtained.

Solids and Water of Muscle, Ovaries, &c.—It is shown that during the sojourn of the fish in fresh water there is a steady loss of solids from the muscles and a steady gain of solids by the genitalia, and that the gain of solids by the genitalia is small compared with the loss of solids from the muscle, that in fact the greater part of the solids lost from the muscles are used for some other purpose than the building up of the genitalia.

Fats of Muscle, Ovaries, &c.—Nothing is more extraordinary than the enormous accumulation of fats which takes place in the muscle of the salmon during its visit to the sea. Not only is the tissue between the individual fibres loaded with fat, but, as shown by Mr. Mahalanobis, an intrafibrous and interfibrillar accumulation of fat occurs. In the river, as the season advances, this accumulated fat steadily disappears from the muscle. There is no reason to suppose that anything of the nature of a degeneration occurs. The fat is simply excreted from the muscle to supply the fat of the growing genitalia, or used in the muscle as a source of energy.

In the muscles the fatty acids are chiefly in the form of ordinary fats. In the ovaries and testes, on the other hand, the fatty acids are largely combined with phosphorus as lecithin. An important decomposition and reconstruction of the fats thus occurs in the growing ovaries. In the ovaries the amount of lecithin is very large, while the amount in the testes is by no means trifling, and the constant occurrence of this substance seems to point to it as the first stage in the formation of nucleins.

Proteids of Muscle, Ovaries, &c.—Dr. Boyd's observations indicate that the albuminous materials of the muscle may be divided into two classes: (1) those soluble in salt solution; (2) those not soluble in salt solution. He shows that globulin substances constitute nearly the whole of the soluble proteids, and that proteoses and peptones are not present in any circumstances. He further shows that there is a small quantity of some phosphorus-containing proteid—either a nuclein or a pseudo-nuclein—among the soluble proteids. It is these soluble proteids which diminish in fish in fresh water. When they are abundant, as in fish at the mouth of the river, on boiling they may coagulate between the flakes of the muscle, and form with the fats the characteristic *curd*.

Of the insoluble proteids, part is composed of white fibrous tissue, part of a phosphorus-containing proteid which may be called myostromin.

Dr. Dunlop's results show more fully the extent to which proteids accumulate in the muscles, and the rate at which they diminish as the fish passes up the river. The first point of interest is that the proteids do not disappear to anything like the same extent or at the same rate as the fats. The second point of interest is that the proteid surplus available for energy—that is, the proteid not used in building the ovaries—is no greater in the upper water fish in October and November than in July and August. This seems to indicate that quite early in the season, while the ovaries are growing slowly, the proteids disappearing from the muscle are more than sufficient to meet the requirements of these structures; while later in the year, when the growth of the ovaries is going on more rapidly, all the proteid disappearing from the muscle is transported to and used in them.

Phosphorus of Muscle, Ovaries, &c.—It is shown that in the female fish only just enough phosphorus is accumulated in the muscle to supply the wants of the growing ovaries, while in the male the accumulation is superabundant. In this connection it is further pointed out that in the male the enormous growth of the bony jaw may use up a further amount of phosphorus. Whether in the female any phosphorus required for the ovaries in excess of that stored in the muscle is procured from the bones, these observations do not indicate.

The phosphorus is stored in the muscle chiefly as phosphates, and to a somewhat smaller extent as lecithin. The amount of lecithin in the muscle is not nearly sufficient to yield the lecithin of the ovaries. In the ovaries the phosphorus is largely in the form of ichthulin, a pseudo-nuclein, so the phosphorus from the phosphates of the muscles must undergo profound changes in the growing ovaries, and being synthesised with organic bodies be built into these compounds. That these compounds are the forerunners of the still more complex nucleins of the embryo is indicated. In the male the transference of the phosphates of the muscle into these higher nuclein compounds is even more direct, and the occurrence of lecithin in considerable amount in the growing testes seems to point to this substance as the first step in the synthesis of inorganic phosphates to nucleic acid.

Iron of Muscle and Ovaries.—Dr. Greig has shown that the ichthulin of the ovaries contains iron, and the amount of iron in the ovaries thus increases as the organs grow. Whence is this iron procured? It has been shown that the iron lost from the muscle is insufficient to yield the iron gained by the ovaries, and it is thus probable that the hæmoglobin of the blood must be drawn on for this element. The liver does not seem to yield iron to the ovaries.

Pigments of Muscle, Ovaries, &c.—Miss Newbigin's study of the pigments of the muscle and ovaries show that two lipochromes are present. First, the very widely distributed yellow pigment, lutein; and second, a bright red lipochrome, which, mixed with the former, gives the characteristic colour to the salmon muscle and ovaries.

Though it has not been possible to investigate the source of the pigments, the evidence adduced tends to show that the characteristic red pigment is probably not derived from the food, but that it is constructed possibly out of the very widely distributed yellow pigment. Its storage in the muscles and its transference to the ovaries is demonstrated. Its fate in the male fish is still obscure, though the deeper pigmentation of the skin in the male suggests its elimination by that channel. What the purpose of the pigment is, is not clearly indicated, though it seems probable that by colouring the ova it may assist in their concealment during development.

Nature of the Transference of Material.—These observations throw important light on the nature of the transference of material. They clearly show that nothing of the nature of a degeneration in the muscle takes place. The muscles simply excrete or give out the material accumulated in them, or utilise it as a source of energy within themselves.

Source of the Energy for Muscular Work, &c.—The extent to which the fats and proteids lost from the muscles are used for the construction of the genitalia on the one hand, and for the liberation of energy on the other, varies somewhat in males and females. Taking the earlier months—to August, it is shown that in the female 12 per cent. of the fats and 3 per cent. of the proteids go to the ovaries, the rest being available for energy; while in the male about 5 per cent. of the fats and 14 per cent. of the proteids go to the testes.

The total energy liberated from fats and proteids is possibly somewhat greater in the male than in the female, being to August 1,271,000 kgms. per fish of standard length in the female, and 1,380,000 kgms. in the male. Of the energy thus liberated about 2200 kgms. are required to raise the fish to the height of the upper water of the river, the remainder being available for the much greater work of overcoming the resistance of the stream, and for internal work and for other calls upon the energy supply.

Of this total available energy in the female, about 20 per cent. is derived from the proteids, while in the male only 9 per cent. is derived from this source. The rest is derived from the fats.

Food Value of Salmon.—The food value per unit of weight of muscle deteriorates as the season advances. In each fish caught in the estuaries the food value remains almost constant, the larger size of the late-coming fish making up for the deterioration of the flesh. The food value of each fish caught in the upper waters is less than that of those caught in the estuaries, and in October and November is only about one-third that of fish caught in the river-mouth. Since the large late-coming fish contain more ova than the smaller fish, their destruction does more damage to the breeding stock.

Factors Determining Migration.—In considering the question of migration, it must be remembered that the Salmonidæ are probably originally fresh-water fish, and that the majority of the family spend their whole life in fresh water. Salmo Salar and other allied species have apparently acquired the habit of quitting their fresh-water home for the sea in search of food, just as the frog leaves the water for the same purpose. When, on the rich marine-feeding grounds, as great a store of nourishment as the body can carry has been accumulated, the fish returns to its native fresh water, and there performs its reproductive act.

That the passage of the fish to fresh water is not governed by the growth of genitalia and by the *nisus generativus*, is shown by the fact that salmon are ascending the rivers throughout the whole year with their genitalia in all stages of development.

From May to August the fish leaving the sea have about the same amount of material stored in their muscles. During these months the ovaries are yet small, and do not act as a reservoir for stored material. In October and November the estuary fish have a smaller amount of stored material in their muscles, since the period of rapid growth of the genitalia has supervened before the full accumulation of material in the muscles has been accomplished. This rapid growth of the genitalia would withdraw material, and prevent its accumulating in the muscle; and thus, when the necessary amount of stored material was accumulated, it would be distributed between these structures. The late-coming salmon, although the supply of solids in the muscles is smaller, have the ovaries so large that the total store of nutrient material in the fish is just about the same as in those entering the estuaries in the earlier months.

The state of nutrition is the factor determining migration towards the river. When the salmon has accumulated the necessary supply of material, it tends to return to its original habitat.

THE STRAMBERG CORALS.[1]

PROGRESS in the classification of corals has been a passage from fog to fog across lucid intervals cleared by successive systems, which have collapsed under the efforts to improve them. The primæval darkness of Ellis, Guettard and Esper was first lightened in 1830 by the classification of de Blainville, which was obsolete within four years of its publication. A long series of memoirs by Edwards and Haime, begun in 1848, gradually laid the foundations of a system at once more adequate to the wide variations in coral structure, and more natural; but it was not until 1857-60 that the two authors' complete classification was published in the great "Histoire Naturelle des Coralliaires." The essential features of their scheme were the separation of the Palæozoic corals as the order Rugosa, and the division of the later corals into two orders, the Aporosa and Perforata, characterised respectively by a solid and a porous wall. The classification gave helpful guidance to those who chose to use it; but many authors preferred to follow de Fromentel, who in 1861 issued a more artificial but simpler system, based on the mode of association of individual corallites into compound coralla. The life of Fromentel's classification was, from its nature, necessarily brief; while that of Edwards and Haime was weak in so many points, that under the numerous amendments of Étallon, Milaschewitsch, von Zittel, and others, the original boundaries became indefinite, and the system once more involved in fog. In 1884, P. M. Duncan restored order by a revision of the genera of Neozoic corals; he adopted, in the main, the same principles as Edwards and Haime, and his revision is still the most useful handbook to coral classification. It has held this position in spite of repeated attempts to change the whole basis of classification. Thus Pratz in 1882 proposed a scheme founded on the septa; von Heider and Ortmann have advocated another, resting on the formation of the "wall"; and recently Miss Ogilvie has suggested a new arrangement, even more radical in its changes.

Miss Ogilvie's views are propounded in two great papers: one in the *Philosophical Transactions*, in which the general principles are stated; and the second, a monograph of the Stramberg Corals, in which her theories are applied in practice. The former work is already known to readers of NATURE by an explanation written by the authoress (vol. lv. p. 280, January 21, 1897), so that the general principles need not be considered here. It has been found in coral history that the best test of a theory of classification is its results. Students of the corals have always been ready to welcome any morphological light that offered guidance through the taxonomic gloom, and have preferred to judge it by the help given in practical work. We therefore turn to Miss Ogilvie's monograph to see whether her classification associates similar corals, and separates those which are unlike.

The authoress is to be congratulated on her material. The Stramberg Schichten have yielded an instructive fauna, different sections of which have been described in other parts of this work by von Zittel, Cotteau, Böhm, Moericke and Zeise. The beds occur on the boundary between the Cretaceous and Jurassic systems, and their fossils have the usual interest of a transition fauna. Miss Ogilvie has described the corals in detail and with care, and her monograph is illustrated by twelve fine large plates. It is unquestionably a most valuable and extensive addition to our knowledge of the Mesozoic corals,

---

[1] "Die Korallen der Stramberger Schichten," by Maria M. Ogilvie, D.Sc., Palæontologische Studien über die Grenzschichten der Jura- und Kreide-Formation im Gebiete der Karpathen, Alpen und Apenninen. Part vii. Palæontographica Supplement, vol. iii. pp. 73-282, pls. vii.-xviii. (1897).